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RI-LS
WATER RELATIONS
Ground Water
LP-WI

October 23, 1957

COOPERATIVE WATERSHED RESEARCH

WORK PLAN

for

STUDY OF SOIL MOISTURE REGIME AND GROUND WATER UNDER MAJOR FOREST TYPES IN NORTHERN LOWER MICHIGAN

by

W. D. Striffler
Research Forester

Lake States Forest Experiment Station

in cooperation with

Michigan Department of Conservation

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Introduction

The soils of the northern Lower Peninsula of Michigan, glacial in origin, are extremely complex and varied. These soils vary from the poorly and moderately developed soils common to outwash plains and glacial channels, to the heterogeneous soils of the moraines and till plains. They range in texture from sands and sands over clay lens, to loams, clay loams, and sandy clays.

A variety of natural and planted forest types occur on these soils. The lighter and poorly developed sandy soils support a natural cover of scrub oak and pine. As the degree of soil development increases, and thus a higher proportion of silt and clay, these sandy soils tend to support first aspen and finally northern hardwoods. These outwash soils also support red pine and jack pine plantations. The finer textured heavier soils of the moraines and till plains are to a large extent used as agricultural lands. However, where forested, these soils support northern hardwoods. Red pine plantations also occur on the sandier moraine soils.

A knowledge of the soil moisture regime under these various types is important in several respects. A knowledge of the disposition of the water once it enters the soil is important from a water supply viewpoint. The water not lost by evapo-transpiration is the normal source of ground water recharge, therefore the opportunity for ground water recharge under the various forest types should be investigated. The knowledge of the water available under the various stands, plus a knowledge of the water requirements of these stands is important from a silvicultural standpoint when a conversion from one type to another is contemplated.

Scope of Studies

The purpose of this study is to investigate, within general soil types, the soil moisture regime under major forest types of northern Lower Michigan, and also to investigate the ground water fluctuation under these types. These investigations will give a comparison of water use, soil moisture recharge, ground water recharge opportunity, and variations in the ground water under these types studied. This study will be confined to the more important forest types of northern Lower Michigan including northern hardwoods, aspen, oak, and red and jack pine plantations. The nature of the study is to collect periodic soil moisture data to determine and compare the levels of soil moisture depletion, recharge, and storage under the various forest types. Associated with the determination of the moisture depletion under these types will be the investigation of the ground water regime. By comparing ground water levels under the various forest types and within a soil type, we may determine whether or not forest cover types affect the opportunity for ground water recharge.

METHODS

FIELD MEASUREMENTS

The study is designed to provide a series of comparisons of soil moisture and ground water levels from the major soil cover complexes of Michigan's Lower Peninsula. One comparison is between stations or locations, each of which represents a major soils series. Another comparison is between cover types within each station. Each station consists of 2, 3, or 4 plots including an open area and 2 or 3 major forest types. Table 1 shows present station and plot selection by soil and forest type. All plots within a station are comparable with respect to soil type, slope, position on slope, and aspect. Plots are 1/2-acre in size (148' x 148'), with a border strip 1 chain wide around each plot. However, in keeping with the conformity of the land, it may become necessary to alter the shape or even sub-divide the plot into two 1/4-acre sub-plots. Plots within hardwood types are marked by painting a stripe on the trees along the boundary. Plots within pine plantations are delineated by a pruned path along the edges. This not only clearly defines the plot but also improves maneuverability around the plot.

Field measurements to be taken are herein divided into initial measurements and periodic measurements. The preliminary measurements serve the purpose of defining the plot characteristics. These include the characteristics of each plot which are to be measured just once. The periodic measurements include soil moisture, precipitation, and depth to water table and are measured at regular intervals throughout the year.

Initial Measurements

1. Soils: Soils are to be classified by standard soil survey procedures. All plots within a station are to be on similar soils. Form SCS-232C attached in appendix will be utilized in describing the soil. In conjunction with the soil classification, the humus on each plot will be classified according to the SSSA procedure. An estimate of stone content by one foot intervals in each plot will be accomplished by digging pits adjacent to each plot, collecting samples of known volume, and extracting the stone. Estimates of bulk density will also be made by collecting undisturbed soil samples from each plot.

2. Vegetation: The vegetation on each forested plot will be cruised by species for trees one inch of d.b.h. and larger. Standard cumulative tally sheets will be used for these cruises. Average age of the stand will be determined by measuring 3 to 5 trees on each plot. Crown densities for each plot will be determined by use of a sperical densitometer.

3. Physiographic Features: The slope, position of slope, and aspect of each station shall be recorded. All permanent plot characteristics will be summarized in a summary table of plot characteristics.

Periodic Measurements

1. Soil Moisture: Soil moisture will be sampled once a month from each plot. Samples will be taken in triplicate from the 0-1, 1-2, 2-3, 3-5, and 5-7 foot intervals. Sampling points are predetermined as illustrated in Figure 1. Initial sampling points were selected to give a reasonable distribution over the plot, thus the initial

sampling points are uniformly spaced on a line diagonally across the plot. Subsequent sampling points are determined by merely advancing in a direction away from base line, a distance of six feet from the previous sampling point. Previous sampling points are marked by a stake which is advanced to the new point. This greatly speeds up location of the points to be sampled.

Sampling method is gravimetric with the Veihmeyer tube. Field Form #1 will be used for field, laboratory, and office records and computations.

2. Ground Water: Wells to measure the depth of the ground water are being installed by various methods depending upon the nature of the soil and underlying strata. On the sandy soils wells are being jetted and driven until the first water is encountered. In the finer textured soils, it is anticipated that wells will have to be drilled on the sandy soils and that water will be encountered at 35 to 70 feet. In the heavier textured soils, knowledge of adjacent wells leads us to believe that water lies at 70 feet. Wells consist of 1 1/4-inch galvanized water pipe with a 24-inch or 30-inch drive point and screen.

The depth to the ground water will be measured weekly, care being taken to measure each station at approximately the same hour each week, thus reducing variation due to diurnal fluctuations. Measurements will be accomplished by lowering a tape down wells and recording the mark the water leaves on the tape plus the reading at the ground surface. The difference will give the depth to ground water in feet and tenths of feet. Field Form #2 will be used to record ground water levels.

3. Precipitation: Precipitation will be recorded weekly at each station by means of a standard rain gage placed in the open plot of each station. Winter precipitation will be measured by removing the inner cylinder and funnel of the standard rain gage and catching snowfall in the can. Inches of water may be determined by either melting the snow and measuring or weighing the sample and applying a conversion factor. As an additional check, a snow board (18" x 18" plywood covered with white flannel) will be placed adjacent to the gage and snow depth and water equivalent of the accumulation measured weekly.

ANALYSIS OF DATA

Soil Moisture

1. The procedure as outlined by Olsen and Hoover (Methods of Soil Moisture Determination Under Field Conditions, Station Paper No. 38, SEFES.) for gravimetric sampling will be utilized. Samples will be weighed, dried at 105°C., reweighed, and the loss moisture expressed as a percentage of dry weight. Soil moisture, expressed as a percentage of dry weight, will be converted to a percentage by volume using bulk density values, and finally will be expressed in inches of water per foot depth of soil. Final values will be corrected for average stone content in each sampling interval, providing stone content is significant.
2. A determination of adequacy of sampling in triplicate will need to be made. It is anticipated that a study will be made concurrently with this study to determine the variation of soil moisture within an acre of ground on several soil textures and under various vegetative and moisture conditions. This will entail a separate work plan. Until

this information becomes available, a preliminary estimate of sample size may be determined from the equation:

$$n = \frac{4s^2}{L^2}$$

in which "s" is an estimate of the population standard deviation and "L" is the allowable error (Snedecor, Section 17.6, 5th Edition).

3. Soil moisture will be analyzed primarily by comparison of graphed soil moisture levels. Comparisons will include: between plots within stations, and between stations by cover types. Statistical analysis, by analysis of variance techniques, will be made if deemed necessary.

Ground Water

Ground water levels, as measure, will be analyzed the same as soil moisture. Graphs will be maintained showing comparisons between plots within stations, and between stations by cover types.

Precipitation

Rainfall records will be maintained to determine the amount of water made available to the soil during each month.

DURATION OF STUDY

This study will continue a minimum of one cycle of soil moisture withdrawal and winter recharge. The study will start August 1957 and continue through August 1958, at which time a decision will be made how long the study in its present form should be maintained.

PRESENTATION OF RESULTS

It is anticipated that the results of this study will be presented in the form of a Station Paper. Certain phases are expected to be adaptable to Technical Notes. An article for the Journal of Forestry, or the Journal of Soil and Water Conservation is also planned.

WORK SCHEDULE

The initial work of setting up the study includes plot location, well driving, and the collection of preliminary data. The routine work schedule includes soil moisture sample collection, processing, and computation, collection of weather records, and the collection of soil samples and their processing and computation. The man-days required for each phase are estimated below:

Initial	Man-Days	
	Striffler	Other
Plot Establishment	10	5
Plot Cruise	5	10
Well Driving	6	18
Instrumentation	3	
Routine		
Soil Moisture Sampling, Weather Records, and Ground Water Levels	40	20
Soil Moisture Lab Work	-	20
Office Computations	5	10
Soil Sampling and Analysis	10	10

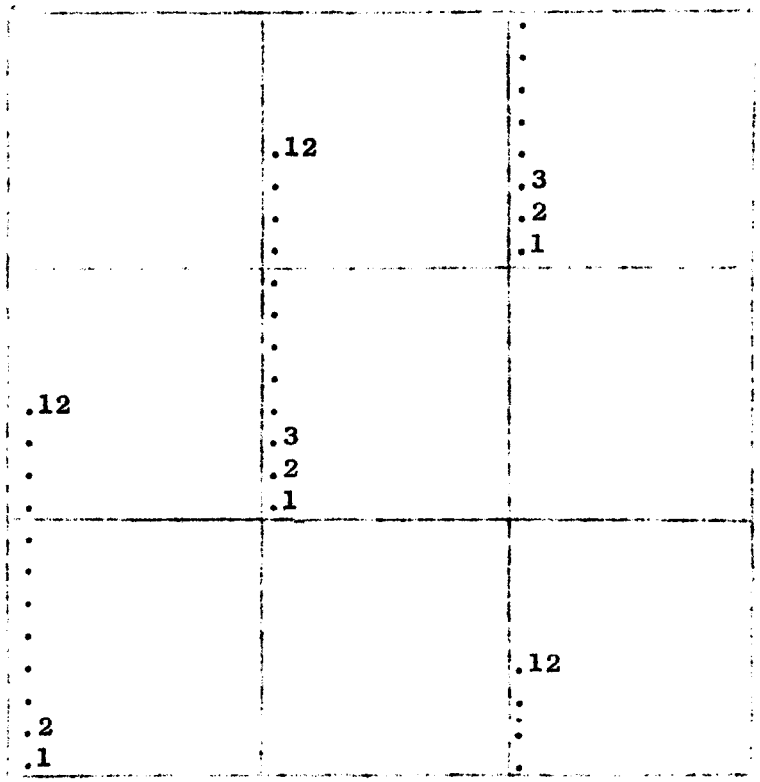
Table 1.

Soil Moisture Station and Plot Data

Station	Plot	Cover Type	Soil Type	Texture of Parent Material or Lower Strata
A;	1	Open	Kalkaska	Sand with a sandy clay layer below standard auger depth
	2	N. Hardwoods		
B	1	Open	Grayling	Sand
	2	Red Pine		
	3	Oak		
C	1	Open	Grayling	Sand
	2	Red Pine		
	3	Oak		
D	1	Open	Kalkaska	S_and
	2	Red Pine		
	3	N. Hardwoods		
E	1	Open	Mancelona ?	Coarse gravel over a sandy clay loam to sandy clay
	2	Red Pine		
	3	N. Hardwoods		
F	1	Open	Grayling	Sand
	2	Red Pine		
	3	Oak		
G	1	Open	Nester	Clay loam to silty clay loam
	2	N. Hardwoods		

Figure 1. Sampling Pattern for Soil Moisture

Plots are 1/2 acre in size (148 x 148 feet). Sampling points are 6 feet apart and consecutive sampling points are indicated by numbers.



Base Line

RI-LS
WATER RELATIONS
Ground Water

December 5, 1957

A PROSPECTUS FOR A STUDY OF

Soil Moisture and Ground Water in Northern Lower Michigan

1. Originating unit: Lower Peninsula Forest Research Center
   Lake States Forest Experiment Station

2. Assignment: W. D. Striffler, Research Forester (Influences)

3. Starting Date: Fall, 1957 Duration: 1 to 2 years.

4. The Problem: Michigan's valuable water resource is dependent on a stable ground water supply. Some of the manageable physical characteristics of watersheds that are believed to affect ground water supplies are soils and cover. The extremely complex and varied soils of Michigan's northern Lower Peninsula support a variety of natural and planted cover types. This study is the initial phase of a comprehensive investigation of the watershed characteristics affecting ground water recharge and depletion, and is designed to investigate the pattern of ground water and soil moisture recharge and depletion on the major soils-vegetation complexes of Michigan.

5. Objective:

   A. To determine and compare the pattern of soil moisture and ground water recharge and depletion between oak, aspen, red pine, and northern hardwood forest types within general soil types.

   B. To determine and compare the pattern of soil moisture and ground water recharge and depletion within individual forest types, but between the soils upon which they occur.

6. Method: Soil moisture measurements are gravimetric with the Veihmeyer tube. Sampling is in triplicate from the 0-1, 1-2, 2-3, 3-5, and 5-7 foot intervals. Sampling points are predetermined giving a uniform distribution over the 1/2-acre plots. Ground water wells are 1 1/4-inch galvanized pipes with screens installed by jetting, drilling, or driving. Measurements are accomplished by lowering a tape and recording the depth to water.

7. Areas Selected: Include the Pine River Research Forest plus additional plots within the Manistee National Forest and adjacent areas.